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IS 11745 (1986): Technical supply conditions for positive displacement pumps - reciprocating [MED 20: Pumps]

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(Reaffirmed 2001)

Indian Standard

TECHNICAL SUPPLY CONDITIONS FOR POSITIVE DISPLACEMENT PUMPS — RECIPROCATING

1. Scope — Covers the technical supply conditions for reciprocating positive displacement pumps for use in special applications like oil exploration and its transportation, fertiliser and process industries, etc.

2. Standard Units — The standard units used in this standard are as follows:

2.1 *Volume* — This shall be specified in:

a) Litre (l) and

b) Cubic metre (m^3).

2.2 *Rate of Flow* — This shall be expressed in:

a) Cubic metres per hour (preferable this shall be used)

b) Litres per minute, and

c) Litres per second.

2.3 *Head* — This shall be expressed in metre, formula used in converting pressure in the head.

$$H = \text{Pressure in kgf/m}^2 \times \frac{10}{\text{density in kg/dm}^3}$$

2.4 *Dynamic Viscosity* — This shall be expressed in centipoise (cP).

2.5 *Kinematic Viscosity* — This shall be expressed in centistoke.

2.6 *Pressure* — The pressure shall be specified in Pascal.

2.7 *Temperature* — The temperature shall be specified in degree Celsius (°C)

3. Terminology

3.1 *Terminology* — Generally the terms used in the standard shall be as given below.

3.1.1 *Power pump* — is a reciprocating pump driven by power from an outside source applied to the crank shaft of the pump.

3.1.2 *Piston or plunger load* — is the force acting on one plunger or piston during any portion of the pumping cycle.

3.1.3 *Maximum allowable speed* (RPM) — is the highest speed at which the manufacturer's design shall permit continuous operation.

3.1.4 *Minimum allowable speed* (RPM) — The lowest speed of which the manufacturer's designs shall permit continuous operation.

3.1.5 *Maximum allowable temperature* — The maximum continuous temperature when handling the specified fluid at the specified pressure.

3.1.6 *Maximum allowable working pressure* — The maximum continuous pressure for which the manufacturer has designed the equipment, when handling the specified fluid of the specified temperature and capacity.

3.1.7 *Rated discharge pressure* — The discharge pressure of the pump having a rated capacity, speed, suction pressure, specific gravity and viscosity.

3.1.8 *Vapour pressure* — Every liquid at any temperature above its freezing point exerts a pressure due to formation of vapour at its free surface. This pressure is known as the vapour pressure of the liquid.

Pumps Sectional Committee, EDC 35 [Ref : Doc : EDC 35 (4226)]

Adopted 22 September 1986

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NEW DELHI 110002

3.1.9 *Rated capacity* — is the total volume of fluid actually delivered per unit of time at the stated operating conditions, this includes both liquid and any dissolved or entrained gases.

3.2 *Rating* — The following terms are used to designate (or are used in connection with) pump rating. These ratings are determined by pump design and not by conditions of specific application.

3.2.1 *Volumetric efficiency* — The ratio of the pump suction capacity to pump displacement and is expressed as a percentage and calculated as follows:

Volume efficiency in open system (for water)

$$= \frac{1 - P\beta t\left(1 + \frac{C}{D}\right)}{1 - P\beta t} - S$$

Volume efficiency in closed system (for water)

$$= 1 - P\beta t\left(1 + \frac{C}{D}\right) - S$$

Volume efficiency in open system (for hydrocarbons)

$$= 1 - \left[S - \frac{C}{D}\left(1 - \frac{\rho_d}{\rho_s}\right)\right]$$

Volume efficiency in closed system (for hydrocarbons)

$$= 1 - \left(1 - \frac{\rho_s}{\rho_d}\right)\left(\frac{C + D}{D}\right) + S$$

where

P = discharge pressure minus suction pressure (kg/m^2)

β = compressibility factor at temperature,

C = fluid chamber volume in the passage of chamber between valves when piston is at the end of discharge stroke in cubic metre,

D = volume displacement per piston in cubic metre,

S = valve slip (in decibels)

ρ_s = density in kg/cm^3 at suction pressure, and

ρ_d = density in kg/cm^3 at discharge pressure.

3.2.2 *Pump efficiency (mechanical efficiency)* — is the ratio of the pump power output to the pump power input.

3.2.3 *Net positive suction head (NPSH)* — is the total suction head of liquid in metres absolute.

3.2.3.1 *Available net positive suction head (NPSHa)* — The total suction head, deducting, system acceleration head, available at the pump suction connection, minus the vapour head (vapour pressure — converted in head) of the liquid of pumping temperature. This is expressed in metre.

3.2.3.2 *Required net positive suction head (NPSHr)* — The total suction head, including pumps acceleration head, required by the pump at the pump suction connection, minus the vapour pressure of the liquid of pumping temperature. This is expressed in metre.

3.2.4 *Acceleration head (ha)* — The pressure changes due to changes in velocity in the piping system and may be calculated as follows:

$$ha = \frac{LVRC}{\text{kg}}$$

where

ha = acceleration head in metre,

L = length of suction line in metre,

V = velocity in suction line,

R = pump speed (RPM), and

C = constant (for type of pump).

3.2.5 *Friction head* — The hydraulic pressure exerted to overcome friction resistance of a piping system to liquid flow.

3.2.6 *Static head* — The hydraulic pressure exerted at the pump by the liquid at rest.

3.2.7 *Flooded suction* — Implies that the liquid shall flow from an atmosphere vented source to the pump without the average pressure at the intake port of the pump, dropping below atmosphere pressure with the pump operating at specified capacity.

3.2.8 *Static suction lift (hss)* — The hydraulic pressure below atmospheric of the intake port of the pump with the liquid at rest.

It is usually expressed in millimetre of mercury vacuum.

3.2.9 *Total suction head (hs)* — The total hydraulic pressure above atmospheric at the intake port while the pump is in operation and is the difference between the intake static head and the intake friction head.

3.2.10 *Total suction lift (hs)* — The total hydraulic pressure below atmospheric of the intake port while the pump is in operation. The sum of the static suction lift plus the intake friction head or the difference between the intake friction head and the static suction head.

3.2.11 *Total discharge head (hd)* — The total hydraulic pressure at the discharge port while the pump is in operation and is the sum of the discharge static head and the discharge friction head.

3.2.12 *Total head (h)* — The difference between the total discharge head and total suction head, or the sum of the total discharge head and total suction lift head.

4. Types of Pumps

4.1 *Power Pump* — Power pump is reciprocating pump driven by power from an outside source applied to the crank shaft of the pump. Power pumps fall into six basic types (*see* Fig. 1 to 3).

4.1.1 *Single pump (simplex)* — A single pump is a reciprocating pump having one piston or its equivalent single or double acting plunger.

4.1.2 *Duplex pump* — A duplex pump is a pump having two pistons or their equivalent single or double acting plungers.

4.1.3 *Triplex pump* — A triplex pump is reciprocating pump having three pistons or their equivalent single or double acting plungers.

4.1.4 *Multiplex pump* — A multiplex pump is a reciprocating pump having more than three pistons or their equivalent single or double acting plungers.

4.1.5 *Horizontal pump* — A horizontal pump is reciprocating pump having the axial centre-line of the cylinder or cylinders in a horizontal position.

4.1.6 *Vertical pump* — A vertical pump is a reciprocating pump having the axial centre-line of the cylinder or cylinders in a vertical position.

4.2 *Selection Procedure/Application of Reciprocating Pump*

4.2.1 *Enquiry* — The purchaser shall complete the data as given in Appendix A to the extent possible and applicable and also specify any known abnormal conditions of working. In addition purchaser may also specify any of his additional requirements.

4.3 *Proposal*

4.3.1 The supplier shall include a data sheet in his proposal as per Appendix A Any other details required by the purchaser shall also be included.

4.3.2 The proposal shall include either a specific statement that all equipment are in strict compliance with the purchaser s specification or a specific list of deviation therefrom shall be furnished.

4.3.3 The supplier shall also submit a list of spare parts which are recommended for normal maintenance of the machine.

4.3.4 The conditions for erection and commissioning of the pumps shall be as agreed to between the supplier and the purchaser.

4.4 *Pump Selection*

4.4.1 *Selection methods* — Pumps shall be usually chosen by one of the three methods:

a) The prospective purchaser shall supply one or more manufacturers with complete details of the pumping conditions and request a recommendation and bid on the units which appear best suited for the conditions;

b) The purchaser shall make a complete calculation of the pumping system and then choose a suitable unit from current catalogues and rating charts, or

c) A combination of these two methods shall be used to arrive at the final selection.

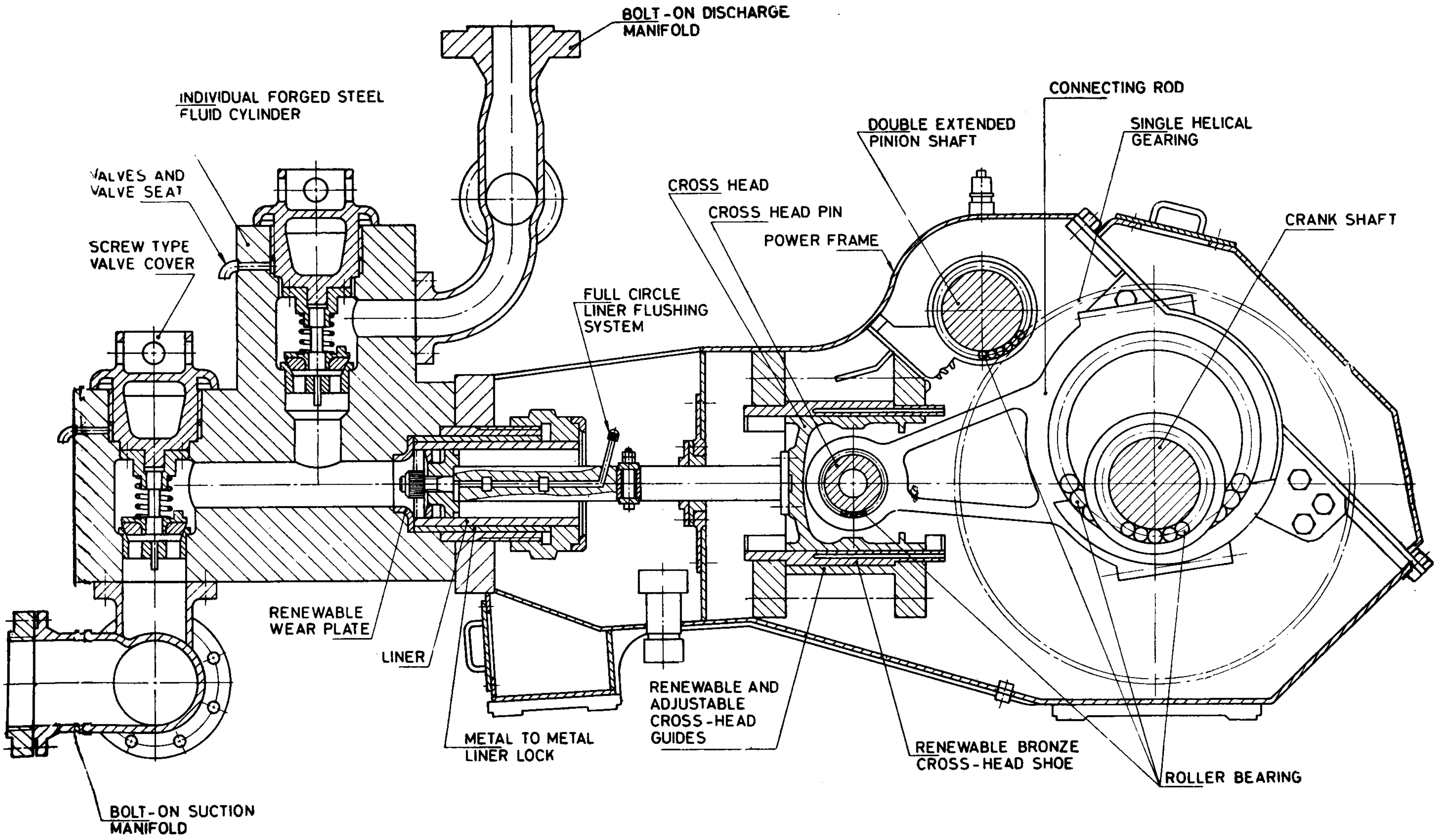
BOLT-ON DISCHARGE MANIFOLD
INDIVIDUAL FORGED STEEL FLUID CYLINDER
VALVES AND VALVE SEAT
SCREW TYPE VALVE COVER
FULL CIRCLE LINER FLUSHING SYSTEM
CROSS HEAD
CROSS HEAD PIN
POWER FRAME
DOUBLE EXTENDED PINION SHAFT
CONNECTING ROD
SINGLE HELICAL GEARING
CRANK SHAFT
RENEWABLE WEAR PLATE
LINER
METAL TO METAL LINER LOCK
RENEWABLE AND ADJUSTABLE CROSS-HEAD GUIDES
RENEWABLE BRONZE CROSS-HEAD SHOE
ROLLER BEARING
BOLT-ON SUCTION MANIFOLD

FIG. 1 GENERAL SECTION FOR PT PUMP

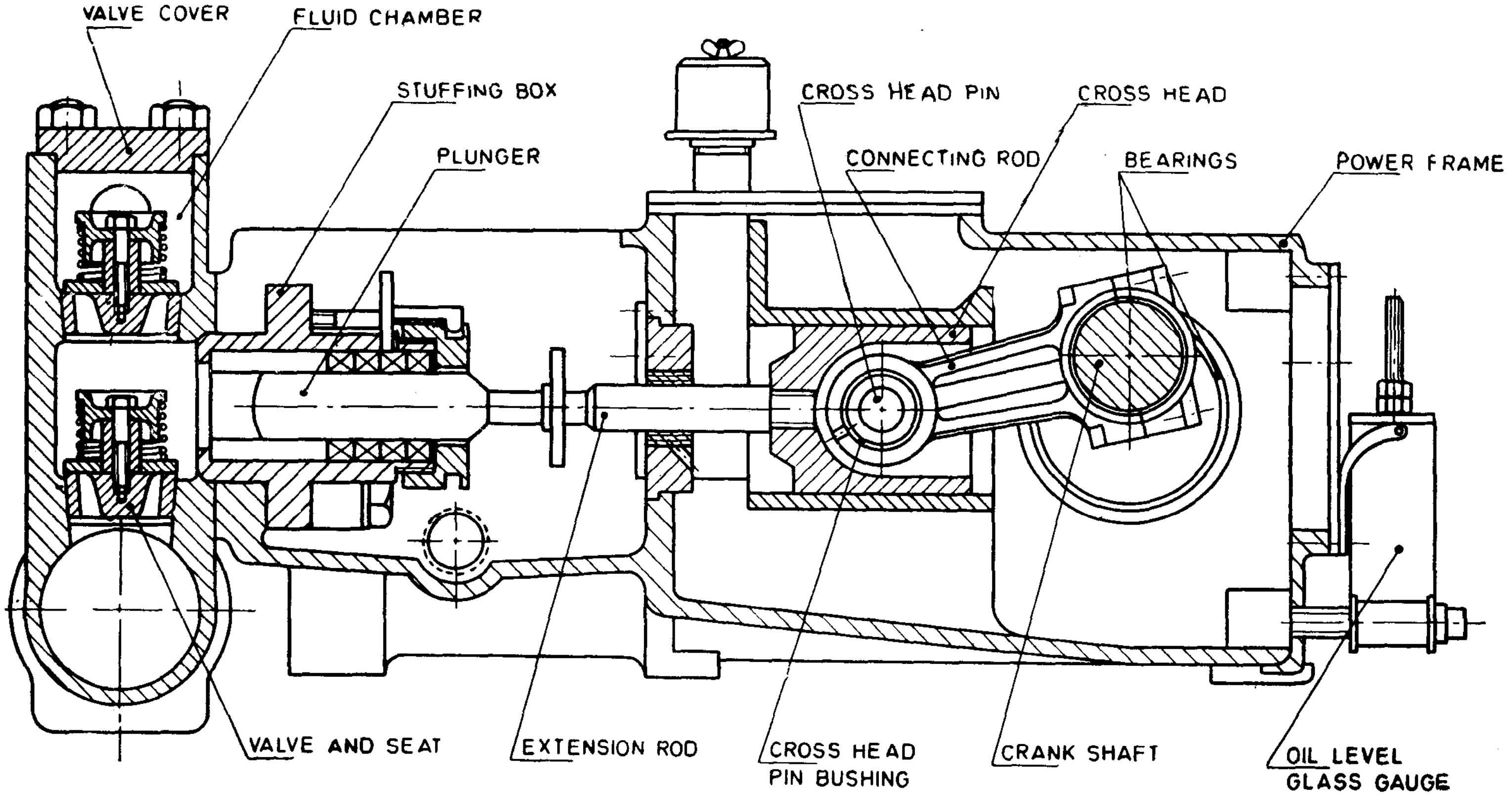

FIG. 2 PLUNGER PUMP

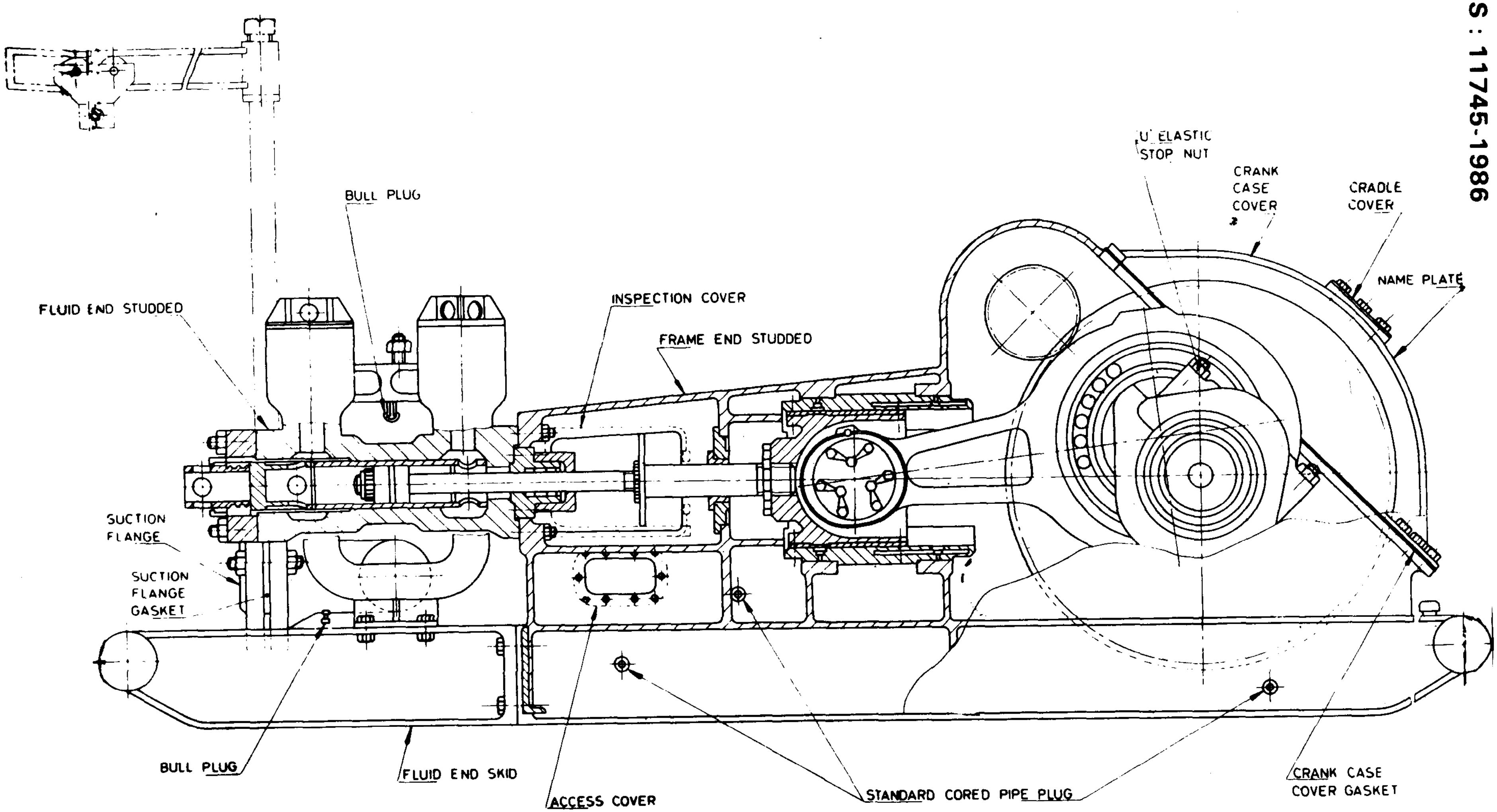

FIG. 3 PISTON PUMP

Regardless of which method shall be used to select pumping equipment, responsibility for accurate determination of operating conditions shall rest with the purchaser. Even though purchaser supplies a manufacturer with all pertinent data to calculate required flow, total head, and suction conditions, purchaser shall satisfy himself that the resultant operating condition determinations are correct. The manufacturer's sole responsibility shall be to provide equipment that meets the stated operating conditions in all respects.

4.4.1.1 *Manufacturer's choice* — This method shall be used for large pumps, for jobs having unusual conditions, and in instances where the engineer shall not have the time or desire to choose the pump himself. Though it appears to relieve the engineer of much of the responsibility in the choice of the pump, it actually shall not. Recommendations and bids shall be evaluated, and to do this requires a complete knowledge of the pumping problem, the relative merits of various designs, and the economics of the installation.

4.4.1.2 *Data for manufacturer* — Summarize the essential data required by any pump manufacturer before a recommendation and bid shall be prepared. Many manufacturers shall have forms which the engineer shall fill up when requesting a recommendation. These shall be extremely useful because they help prevent omission of important data.

When supplying data to a manufacturer extreme care shall be used to see that all the facts concerning the installation shall be given. Incomplete data may lead to a poor or wrong recommendation because the engineer choosing the unit may make the wrong assumptions. Thus, the plant engineer requesting a pump recommendation or bid, shall have a definite responsibility toward the manufacturer, and if this is neglected, the engineer may hardly expect to secure the right pump.

4.4.1.3 *Essential data required in selection of the pump*

a) Number of units required,

b) Nature of the liquid to be pumped:

  1) fresh or salt water, acid or alkali, oil, gasoline, slurry, or paper stock,

  2) cold or hot and, if hot, at what temperature? What is the vapour pressure of the liquid at the pumping temperature?

  3) what is its specific gravity?

  4) is it vicous or non-viscous?

  5) clear and free from suspended foreign matter of dirty and gritty, if the latter, what are the size and nature of the solids, and are they abrasive? If the liquid is of a pulpy nature, what is the consistency expressed either in percentage or in the kg/m^3 of liquid? What is the suspended material?

  6) what are the chemical analysis, *p*H value, etc? What are the expected variations of this analysis? If corrosive, what have been the past experience, both with successful materials and with unsatisfactory materials?

c) *Capacity* — What is the required capacity as well as the minimum and maximum amount of liquid, the pump shall ever be called upon to deliver?

d) Suction conditions:

  1) a suction lift; or

  2) a suction head?

  3) what shall be the length and diameter of the suction pipe?

e) Discharge conditions:

  1) the static head. Is it constant or variable?

  2) the friction head, and

  3) the maximum discharge pressure against which the pump shall deliver the liquid.

f) *Total head* — variations in (d) and (e) shall cause variations in the total head.

g) Is the service continuous or intermittent?

h) Is the pump to be installed in a horizontal or vertical position? If the later, is

  1) in a wet pit?

  2) in a dry pit?

j) What type of power is available to drive the pump and what are the characteristics of this power?

k) What space, weight or transportation limitations are involved?

m) Location of installation:

   1) geographical location,
   2) elevation above see level,
   3) indoor or outdoor installation, and
   4) range of ambient temperatures.

n) Are there any special requirements or marked preferences with respect to the design, construction or performance of the pump?

4.4.2 *Pump specification, data* — Requirements for selection of the pumps shall be:

a) Pump rated capacity,

b) Discharge pressure,

c) Suction pressure/NPSH available

d) Liquid handled:

   1) composition/type;
   2) viscosity at pumping temperature;
   3) vapour pressure at pumping temperature;
   4) specific gravity;
   5) *p*H value; and
   6) solid contents/suspended particles, if any (details required).

e) Location—indoor/outdoor (indicate clearly in case of hazardous locations).

f) Transmission belt/chains/gears.

g) Drive electric motor/diesel engine.

h) Details of electric power supply, if motor drive.

j) Details of utilization and scope of supply.

k) Special details, if any

4.4.2.1 Pump shall be selected on the basis of the following parameters:

a) Capacity (rate of flow), and

b) Pressure.

4.4.2.2 *Plunger diameter* — Shall be selected depending on discharge pressure, higher the plunger diameter, lower is the maximum allowable discharge pressure. It is preferred to keep the plunger diameter as large as possible, since larger the plunger diameter, lower the pump speed and a low pump speed shall always be preferred from operating as well as maintenance point of view.

4.4.2.3 *Pump speed* — Pump speed is proportional to capacity.

4.4.3 *Driver speed* — Reciprocating pumps always run at lower speeds. Hence a gear reducer is always required. Depending on the motor speed and pump speed gear box ratio shall be decided and *vice-versa*.

Driver speed = Pump speed × gear-box ratio

4.4.4 *Gear box* — Sometimes gear box is inbuilt with pumps. If it is external then it shall be selected based on power pump speed and driver speed according to the recommendations of the gear box manufacturer.

4.4.5 *Suction stabilizer/discharge dampener* — Shall be as per the recommendation of the manufacturer.

4.4.6 *Other accessories and unitization* — Other accessories and unitization shall be selected either as per manufacturer's recommendations depending on application requirement or as per purchaser requirement.

4.4.7 *Application* — Some of the applications for power pumps shall be:

a) Ammonia service,

b) Carbonate service,

c) Chemicals,

d) Crude-oil pipe-line,

e) Cryogenic service,
f) Fertilizer plants,
g) High pressure water cutting,
h) Hydro forming,
j) Hydrostatic testing,
k) Liquid petroleum gas,
m) Liquid pipe line,
n) Power oil,
p) Power press,
q) Soft-water injection for water flood,
r) Slung pipe line (70 percent by weight),
s) Slush ash service,
t) Steelmill descaling, and
u) Water-blast service.

5. Components and Materials

5.1 *Liquid End (Fluid End)* — The liquid end consists of mainly the cylinder, plunger or piston, valves, stuffing box, manifolds and cylinder head, etc.

5.1.1 *Cylinder* — The cylinder is the body where the pressure is developed, it is continuously under fatigue. Cylinders, on many horizontal pumps have the suction and discharge manifolds made integral with the cylinder. Vertical pumps usually have separate manifolds, when a cylinder contains the passage for more than one plunger, it is called an individual cylinder. Individual cylinder shall be used where developed stresses are high.

5.1.2 *Plunger* — The plunger transmits the force that develops the pressure. It is solid up to 120 mm diameter. Above that dimension, it shall be made hollow to reduce weight.

5.1.3 *Pistons* — Pistons are used to water up to 70 kg/cm^2. For higher pressure a plunger is usually used. Pistons are most frequently used on duplex-double acting pumps. The latest trend is to use single-acting pistons on triplex pumps. Piston rods, both liquid and drive shall be of corrosion resistant material.

5.1.4 *Stuffing boxes, packing and glands*

5.1.4.1 Piston rod, stuffing box bore shall have a minimum surface finish value of N9.

5.1.4.2 The piston rod stuffing box shall accept a minimum of three square packing rings or three V-packing rings (with adopters) of a minimum size of 15 mm square.

5.1.4.3 The valve rod stuffing box shall accept a minimum of three square packing rings or three V-packing rings (with adopters) of a minimum size of 10 mm square.

5.1.4.4 Packing requiring lubrication shall be lubricated by oil entrained in gas, by oil fed into the stuffing box on the atmospheric side of the packing, or by oil injected into a lantern ring in the stuffing box.

5.1.4.5 Glands shall be bolted or threaded to be stuffing box. Glands studs shall pass through holes (not slots) in the gland axially-split glands shall be bolted together. Headed gland bolts in a slot shall not be acceptable.

5.1.5 *Liners* — Piston-type liquid end cylinders shall be provided with liners. For piston diameters of 100 mm or less, the liner may be pressed into the cylinder. For piston diameters larger than 100 mm, the liner shall be flanged and bolted to the cylinder, non-pressed liners shall seal against the cylinder with a gasket or O-ring.

5.1.6 *Valves* — Valve use depends on the application. The main parts of the valve are the seat and the plate. The plate movement shall be controlled by a spring or retainer, usually use a taper where it fits into the cylinder or manifold. The taper not only gives a positive fit, but also permits easy replacement of the seat.

Note — Some pumps use the same size suction and discharge valves for interchangeability, some use longer suction valves than discharge valves for NPSHr reasons other have large discharge valve than suction valves because the discharge valve is on top of the suction valve.

5.1.7 *Manifolds* — These are the chambers where liquid is dispressed or collected for distribution before or after passing through the cylinder. On horizontal pumps the suction and discharge manifold is usually made integral with the cylinder. Some horizontal pumps and vertical pumps have only the discharge manifold integral with the cylinder Most vertical pumps have the suction and discharge manifold separate from the cylinder.

5.1.7.1 Suction manifolds shall be designed to eliminate air pockets from the flange to the valve entrance. Separate suction manifolds are cast iron or fabricated steel. Discharge manifolds are steel forging or fabricated steel. The manifolds shall have a minimum deflection to prevent gasket shift when subjected to the plunger load.

5.2 *Power End*—The power end contains the crankshaft, connecting rod, cross head, pony rod, bearings and frame. Basic designs are horizontal and vertical with sleeve or antifriction bearings.

5.2.1 *Frame*—The frame absorbs the plunger load and torque. On vertical pumps with an outboard stuffing box. The frame is in compression with horizontal single-acting pumps, the frame is in tension. Frames are usually close grain cast iron. Slurry pump frames, designed for mobile service at various sites, are usually fabricated steel. The frame shall be vented to the atmosphere.

5.2.2 *Crankshaft*—Crankshafts shall be wrought or cast in one piece. In horizontal pumps, the crankshafts are usually nodular iron or cast steel. Vertical pumps use forged steel or machined billet crankshafts, because the crankshafts have relatively low speeds and mass counter weights are not used.

5.2.3 *Connecting rod*—The connecting rods transfer the rotating force of the crankpin to an oscillating force the wristpin. Connecting rods are split perpendicular to their centre line at the crankspin and for assembly of the rod on to the crankshaft.

5.2.4 *Wristpin*—Located in the cross head, the wristpin transforms the oscillating motion of the connecting rod to reciprocating motion.

5.2.5 *Cross head*—The cross head moves in a reciprocating motion and transfers the plunger load to the wristpin. The cross head is designed to absorb the side or radial load from the plunger as it moves linerly on the cross way. Cross heads are grooved for oil lubrication with a bearing surface finish valve of N9. Cross heads are piston type (full round) or partial contact. The piston type shall be open end or vented to prevent air compression at the end of stroke. On vertical pumps the pull rods go through the cross head so that the cross head is under compression when the load is applied.

5.2.6 *Bearings*—Both sleeve and antifriction bearings shall be used in power pumps. Some frames use all sleeve, others use all antifriction and others use a combination of both.

5.2.6.1 Quintuplex pumps shall have a minimum of three main bearings.

5.2.6.2 Multiplex pumps and larger shall have a minimum of four main bearings.

5.2.6.3 If antifriction bearings are used, they shall have a minimum rated life of either 25 000 hours with continuous operation at rated conditions or 16 000 hours at maximum axial and radial loads and rated speed (the rated life is the number of hours at rated bearing load and speed that 90 percent of the group of identical bearings shall complete or exceed before the first evidence of failure).

5.3 *Lubrication*

5.3.1 *Lubrication, power end*—The power and lubrication system may be splash, pressure, or positive gravity as recommended by pump manufacturer or shall be as specified by the purchaser, a sight glass, gauge or oil-level dip stick shall be provided.

5.3.1.1 All pressure containing parts in the oil system shall be of steel, unless otherwise approved by the purchaser.

5.3.1.2 A power end pressure lubrication system shall incorporate a nominal 25 micron or finer-filter. The filter shall be accessible for servicing.

5.3.1.3 A power end pressure lubrication system shall include a low oil pressure switch.

5.3.2 *Lubrication liquid end*

5.3.2.1 When specified by the purchaser, a mechanical lubricator shall be furnished for stuffing-box lubrication and any other points requiring lubrication.

5.3.2.2 All lubricator feeds shall be rated for the highest pressure into which the lubricator shall pump for injection into a liquid end, stuffing box, lantern ring with packing on both sides, each lubricator feed shall be rated at least equal to pump rated discharge pressure.

5.3.2.3 The lubricator shall be furnished with a separate component for each type of lubricant required. Each lubricant compartment shall be sized for at least 24 hours of operation at the maximum expected pumping rate.

5.3.2.4 Unless otherwise specified, the lubricator shall be mounted on the pump. In power pumps, the lubricator may be mechanically driven from the power frame driving mechanism or may be separately driven.

5.4 *Materials*

5.4.1 Materials of construction shall be as specified by manufacturer for the specified operating conditions, except as required.

5.4.2 External parts subject to rotary or sliding motions (such as control linkage joints and adjusting mechanisms) shall be of corrosion resistant materials suitable for the site environment.

5.4.3 Low carbon or stabilized grades of austenitic stainless steels shall be used when parts made of these materials shall be fabricated, hard surfaced, over laid, or repaired by welding and exposed to a motive or process fluid or to an environmental condition that promotes integranular corrosion.

5.4.4 Where mating parts such as studs and nuts of 18-8 stainless steel or materials having similar galling tendencies are used, they shall be lubricated with a suitable antiseizure compound, mating parts made from materials having galling tendencies shall have a minimum hardness differential of Rockwell C5.

5.4.5 Out of various materials of construction available, a list of a few recommended materials for various components and parts of the pump are given in Appendix B.

5.4.6 Pressure castings in cast iron shall not be welded for repairs.

5.4.7 All castings shall be sound, free of shrink or blow holes, cracks, scale blisters or other similar surfaces of castings shall be cleaned by sand blasting, shot blasting, pickling, etc.

6. Inspection and Testing

6.1 *General*

6.1.1 The purchaser shall specify, if shop inspection by purchaser is required and the tests which are required to be witnessed.

6.1.2 *Where shop inspection is specified* — Inspector representing the purchaser shall have free access at all reasonable times to manufacturer's plant while work on or testing of equipment is being performed.

6.1.3 The purchaser shall receive prior notice of at least a week about mechanical/performance test where this has to be witnessed.

6.1.4 No pressure parts shall be painted unless inspection is complete.

6.1.5 The manufacturer shall furnish the inspector with all necessary certificate on materials, purchase specification for all items on bill of materials, test data, result of quality assurance test to verify whether the specifications as per the order are being met.

6.1.6 Inspection by purchaser's inspector shall not relieve pump manufacturer of his responsibility in any way.

6.2 *Inspection* — Normally the type of inspection shall be done are radiography examination, ultrasonic, dye penetrant and magnetic particle, flaw detection and if any way the parts, that is, cylinder, plunger/piston, fluid end and connecting rod, etc.

These shall be done as per relevant Indian Standards according to **6.2.1** to **6.2.3**. Other code may be followed as per the agreement of the purchaser and the supplier.

6.2.1 *Radiographic examination*

a) IS : 4853-1982 Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes (*first revision*).

b) IS : 1182-1983 Recommended practice for radiographic examination of fusion welded butt joints in steel plate (*second revision*).

c) IS : 2953-1964 Glossary of terms used in radiographic inspection of castings.

6.2.2 *Ultrasonic testing*

a) IS : 7666-1975 Recommended procedure for ultrasonic examination of ferrite castings of carbon and low alloy steel.

b) IS : 7343-1974 Code of practice for ultrasonic testing of ferrous welded pipes and tubular products.

c) IS : 4225-1979 Recommended practice for straight beam ultrasonic testing of steel plates (*first revision*)

d) IS : 4260-1976 Recommended practice for ultrasonic testing of welds in ferritic steel (*first revision*)

6.2.3 *Magnetic particle inspection*

a) IS : 4901-1968 Code of practice for magnetic particle flaw detection of steel crankshaft forgings.

b) IS : 7743-1975 Recommended practice for magnetic particle testing and inspection of steel forgings.

6.3 Cleanliness shall be done to all cast passage and piping, etc, by pump supplier, these shall be fully cleaned to remove all dirt, rust, mill scale, welding beads or stage or other foreign matter, cleanliness of oil system at all be done carefully.

6.4 When specified by the purchaser, the hardness of parts, welds and heat affected zones shall be verified as being within the allowable values by testing of the parts. The methods extent, documentation and witnessing of test, shall be mutually agreed upon by the purchaser and the supplier.

6.5 The following shall be checked before or during the test:

a) Alignment of pump and driver,

b) Direction of rotation,

c) Electrical connections,

d) Operation of stuffing boxes and lubrication system,

e) Clearance, and

f) Liquid passages.

6.6 *Testing*

6.6.1 Normally the type of testing shall be done are performance test, load tests, hydrostatic test, material tests, etc (*see* Appendix C).

6.6.2 *Performance test* — The manufacturer shall operate pump in his shop for sufficient period to check the speed, discharge pressure, suction pressure, and capacity, etc (*see* Appendix D)

6.6.2.1 Minimum test run shall be for total four hours, with water under following load conditions:

a) Two hours at no load condition

b) Two hours at 49-56 kg/cm^2

6.6.2.2 During the above four hours test following parameter shall be recorded:

a) Fluid and breathing,

b) Vibration,

c) Noise,

d) Bearing temperatures,

e) Oil leakage, and

f) Proper lubrication

6.6.3 *Load tests* — Shall be done for one hour at 105 kg/cm^2 at suitable RPM for duplex/triplex-piston/plunger pumps.

6.6.3.1 For pumps where the working pressure is less than 105 kg/cm^2, shall be tested on full load.

6.6.3.2 For pumps where the working pressure is beyond 105 kg/cm^2, shall be tested at extra charges limited to maximum pressure of 210 kg/cm^2

6.6.4 *Hydrostatic test* — Hydrostatic tests shall be done using water or in special cases, light oil or kerosene, at room temperature and at a pressure equal to one and half times the maximum working pressure unless specified otherwise.

6.6.4.1 Following pressure parts of fluid end assembly shall be subjected to hydrostatic test:

a) Fluid end,

b) Valve cover, and

c) Stuffing box.

6.6.5 *Material tests*

6.6.5.1 *Fluid and assembly* — On demand material test certificate which comprise chemical analysis and physical properties (that is, tensile, impact, etc) shall be submitted for following major pressure parts of fluid end assembly:

a) Fluid end,

b) Valve cover, and

c) Stuffing box.

6.6.5.2 If desired by the customer, the material of construction of the following major components of power end assembly shall be informed to the customer:

a) Power frame,

b) Crankshaft,

c) Connecting rod, and

d) Cross head.

7. Guarantees

7.1 *Performance* — The reciprocating pump shall be guaranteed for satisfactory performance at the specified operating conditions. These include a guarantee for flow rate and power at the time of performance test unless guarantees on other items have been specifically asked by the purchaser. The tolerances to be allowed on the flow rate and power consumption shall be according to IS : 9137-1978 'Code for acceptance tests for centrifugal, mixed flow and axial pumps — Class C'.

7.2 *Workmanship* — All equipments, components and spare parts shall be guaranteed by the supplier against defects which despite proper use appear therein and arise from faulty design, defective or improper materials or poor or faulty workmanship. This guarantee shall be applicable for a period mutually agreed between the purchaser and the supplier. If any defects or malperformance occurs during the guarantee period the supplier shall make all necessary or desirable alterations, repairs and replacements free of charge.

7.3 Any thing, other than the above guarantee condition shall be done as per the agreement between the purchaser and the supplier.

8. Despatch and Marking

8.1 *Despatch (Packing)*

8.1.1 After tests and inspection are completed, all exposed machined surfaces shall be coated with suitable rust preventive coating. Cylinder, pistons and process piping, etc, shall be cleaned and suitably protected to prevent corrosion (*see* IS : 8221-1976 'Code of practice for corrosion prevention of metal and metal components in packages').

8.1.2 Unmachined exterior surfaces shall be painted with heat resistant paints.

8.1.3 Packing wood conforming to IS : 6662-1980 'Timber species suitable for wooden packaging (*first revision*)' and IS : 5247-1983 'Converted timber (coniferous)' shall be used. Joints shall be dust and water proof.

8.1.4 All openings shall be provided with wooden, plastic or metal closures.

8.1.5 In case of export order, top cover of the case shall be fixed with screws, so that if required by the customs it may be opened for inspection and fitted back.

8.1.6 Components assembly, sub-assembly parts, hardwares, etc, inside the packing shall be done in such a way that they are tightly secured with the packing case and there is no movement of the same inside the packings.

8.1.7 All items shall be packed in polythene cover wherever possible, along with proper tag indicating part description, drawing No./Part No., part list, serial No., reference and quality.

8.2 *Marking*

8.2.1 The following details shall be stamped or embossed on name plate, etc, on the reciprocating pump:

a) Description,

b) Kind,

c) Rated pressure of pump,

d) Rated capacity,

e) Rated speed,

f) Rated temperature,

g) Rated horse power,

h) Stroke,

j) Inside diameter of cylinder,

k) Registered trade-mark or name of the manufacturer,

m) Serial number and year of manufacture, and

n) Direction of rotation of prime mover.

8.2.2 *Marking on packing case*

8.2.2.1 All stencil markings outside the cases shall be of water-proof paint to prevent obliteration in transit.

8.2.2.2 The following details shall be marked on the packing cases clearly:

a) Sales order number

b) Case No.————————of total cases (if cases are more than one)

c) From:

d) To:

e) Size of cases and weight

f) Marking showing sling and C.G. position wherever possible

g) All cases containing fragile items are to be stencilled with red marking and stencilling paint as 'HANDLE WITH CARE'

h) Any other markings required by the customers

j) Pictorial instructions shall be shown on packing [see IS : 1286-1967 'Pictorial markings for handling of goods in general (*first revision*)].

APPENDIX A

(*Clauses* 4.2.1 *and* 4.3.1)

DATA SHEET RECIPROCATING PUMP

OPERATING CONDITIONS		PERFORMANCE	
		NPSH, Required	
		No. of Stages	
Duty :		RPM	
Liquid Handled		Efficiency	
Location : Outdoor ☐ In door ☐		Max Power Absorbed on the Shaft of	
Capacity, Minimum	m^2/h	: Pump—	
Capacity, Maximum	m^2/h	: Reducer—	
Suction Pressure	kg/cm^2		
Discharge Pressure	kg/cm^2		
Differential Head	m		
Fluid Temperature	°C	Tests Required :	
Vapour Pressure at Pumping Temperature	kg/cm^2		
Viscosity CPS at Pumping Temperature			
Sp. Gravity at Pumping Temperature			
Crystallization Point	°C		
NPSH, Available	m	DRIVER : STEAM TURBINE/MOTOR	
Corrosion due to		Driver to be supplied by :	
Solid in Suspension		Recommended HP/kW	
		Recommended RPM	

CONSTRUCTION			
Type :		Lubrication System :	
		Lubrication Pump :	
Cylinder : Horizontal ☐ : Vertical ☐ : Angle ☐		Cooling Heating System :	
No. ϕ : mm, Stroke	mm	Cooling Heating Fluid :	
Plunger/Piston Dia	mm	Introduced at a Temp of	°C
Average Piston Speed :	m/sec	Washing System for Piston :	
Piston Guides : No. : : Distance	mm	Injecting Fluid	
Connecting Rod : Centre to Centre	mm	Capacity of Injecting Fluid	m /h
Small End Bearing : $\phi \times L$	mm	Wt of : Pump without Driver	kg
Big end Bearing : $\phi \times L$	mm	: Heaviest Piece	kg
Main Bearing : $\phi \times L$	mm	: Heaviest Piece for normal maintenance	kg
No. : : Centre to Centre	mm	: Bare Shaft of Pump	kg
Cross Head Sliding Block : Surface	mm^2		
Valve			
Valve Seats			
Valve Springs			
Seal Gaskets			
Piston Seal System :			

NOZZLE	SIZE	RATING	FACING	POSITION
Suction				
Discharge				

MATERIAL OF CONSTRUCTION	
Cylinder	Connecting Rod
Cylinder Liner	Small end Bearing
Plunger/Piston Surface Treat :	Big end Bearing
Power Frame	Main Bearing
Packing	Crosshead Sliding Block
Packing Gland	Piston Guides
Valve	Seal Gaskets
Valve Scats	Other Parts in contact with fluid
Valve Springs	

PREPARED BY :	CHECKED BY :	APPROVED BY :

DATA SHEET RECIPROCATING PUMP

COUPLING BETWEEN DRIVER AND PUMP	MANUFACTURER FINAL DATA
Type :	Manufacturer :
	Pump Serial No. :
Reducer : Type —	Test Curve No. :
Ratio — : Axes —	Outline Drawing No. :
Speed Variator :	Pump Sectional Drawing No. :
Belts or Chain Tracks :	Seal Diameter Drawing No. :
Coupling between : Variator & Driver	Wr Clearance Diameter
: Reducer & Variator/ Driver	Mech Seal/Packing :
: Pump & Reducer	
Cooling Water.	
Inlet Temp °C : Capacity m^2/h	

ACCESSORIES TO BE SUPPLIED

Pressure Indicator : Suction Side
: Discharge Side
: For Low Pressure Oil
: For High Pressure Oil
Temp Indicator for Bearing Metal
Low Pressure Oil Pump :
Motor :
High Pressure Oil Pump :
Motor :
V-Belt
Pulley
Oil Cooler
Motor Bed
Safety Valve on Discharge Side
Companion Flange for Suction Side & Delivery Side

Low Oil Pressure Safety Alarm Switch or Device

Remarks :

PREPARED BY :	CHECKED BY :	APPROVED BY :

APPENDIX B

(*Clause* 5.4.5)

RECOMMENDED MATERIALS OF CONSTRUCTION

Name of Parts	Relevant IS/Equivalent Materials
Fluid End	Forged steel, IS : 2004-1978 'Carbon steel forgings for general engineering purposes (*second revision*)'
Cylinder	IS : 210-1978 'Grey iron casting (*third revision*)'
Cylinder head, valve cover, cylinder liner	IS : 210-1978
Discharge valve stop	IS : 210-1978
Adopter fluid end	IS : 210-1978
Stuffing box and gland	IS : 210-1978
Stuffing box bushing	Brass
Sleeve fluid end adopter	Aluminium bronze
Plunger co-hard	—
Piston	IS : 210-1978, IS : 617-1975 'Aluminium and aluminium alloy ingots and castings for general engineering purposes (*second revision*)'
Piston ring	IS : 8422-1977 'Piston rings for IC engines'
Extension rod	—
Power End	
Power frame	St. 42-S, IS : 226-1975 'Structural steel (standard quality) (*fifth revision*)' and St. 42 W, IS : 2062-1980 'Structural steel (fusion welding quality) (*second revision*)' or Cast iron FG 300, IS : 210-1978
Connecting rod	Class 2 and class 3 of IS : 2004-1978, IS : 617-1975, IS : 961-1975 'Structural steel (high tensile) (*second revision*)'
Cross head	FG 300 IS : 210-1978
Cross head sliding block	—
Crankshaft	—
Plunger shank locking plate	Steel St. 42, IS : 1079-1973 'Hot roller carbon steel sheet and strip (*third revision*)'
Retaining ring	Spring steel
Main bearing housing	Steel cast Gr. 2, IS : 1030-1982 'Carbon steel casting for general engineering purposes', Steel St. 42, IS : 1079-1973
Gear housing	Steel St. 42, IS : 1079-1973
Diaphragm complete	Cast iron FG 300 IS : 210-1978
Small end bearing	Steel
Main bearing	Steel
O-ring/water baffle	Oil resistant synthetic rubber
Gaskets	IS : 2712-1979 'Compressed asbestos fibre jointings (*second revision*)'
Pet cock	Brass/carbon steel
Relief valve, check valve	Forged steel, IS : 2004-1978
Valve spring	Spring steel
V-belt	IS : 2494-1974 'V-belts for industrial purposes (*first revision*)

Name of Parts	Relevant IS/Equivalent Materials
Pipes and fittings	Carbon steel and stainless steel
Pressure gauge	IS : 3624-1979 'Pressure and vacuum gauges (*first revision*)'
Bolts and nuts	IS : 1364-1967 'Precision and semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm) (*first revision*)', IS : 1365-1978 Slotted countersunk head screws (*third revision*)', IS : 1366-1968 'Slotted cheese head screws (dia range 1.6 to 20 mm) (*first revision*)'
Roller bearing, ball bearing	IS : 6456-1972 'Double row radial ball bearings' IS : 6457-1972 'Single row cylindrical roller bearings', IS : 6458-1972 'Double row cylindrical roller bearings'
Other parts in contact with fluid	Suitable grades to be included where applicable

APPENDIX C

(*Clause* 6.6.1)

TEST REQUIREMENT — RECIPROCATING PUMP

S.O.No.	CUSTOMER	ITEM No.	TYPE	QTY

PUMP SPECIFICATION

PLUNGER/LINER SIZE	mm	
STROKE	mm	
CRANK/PINION SHAFT RPM		
DRIVE		
SUCTION CONNECTION		
DISCHARGE CONNECTION		
POWER	kW	

OPERATING PARAMETERS

PUMPING TEMPERATURE	°C	
SP GR AT PUMPING TEMPERATURE		
VAP PRESS AT PUMPING TEMPERATURE	kgf/cm^2	
VISCOSITY AT PUMPING TEMPERATURE		
NPSHR	mwc	
SUCTION PRESS.	kgf/cm^2	
DISCHARGE PRESS.	kgf/cm^2	
FLOW RATE	m^3/h	
LIQUID		

PERFORMANCE TEST	PRESSURE kgf/cm^2	REQD	WITNESS
NO LOAD			
PARTIAL LOAD			
FULL LOAD			

HYDROSTATIC TEST	PRESSURE kgf/cm^2	WITNESS
FLUID END ASSEMBLY		
FLUID END SUCTION CHAMBER		
FLUID END DISCHARGE CHAMBER		
STUFFING BOX		
SUCTION ELBOW/MANIFOLD		
DISCHARGE ELBOW/MANIFOLD		

REMARKS :—

	DATE	PREPARED BY :	CHECKED BY :	APPROVED BY

APPENDIX D

(*Clause* 6.6.2)

PROCEDURE FOR PERFORMANCE TESTING OF PISTON PUMPS

D-1. The pump shall initially be run on no load with water as pumping fluid for general observation with regard to proper assembly, oil leakage, lubrication and bearing temperature.

D-2. It shall then be taken nearly up to the maximum speed and gradually loaded up to full load with an interval of 35 kg/cm^2 At each of these load points, the pump shall be held for a period of 30 minutes and the observations shall be recorded in following *pro forma :*

TEST CERTIFICATE

Pump type..

Pump size..

Pump serial number..

Sales order number..

Name of customer ....

Date of test..

Place of test..

TESTING DETAILS

Time	*Strokes per Minute*	*Discharge Pressure,* kg/cm^2

Chain case oil temperature..

Ambient temperature..

Crank case oil temperature..

Lubrication pressure before filter..

Lubrication pressure after filter..

Chain case oil pressure..

THE PERFORMANCE OF THE PUMP IS FOUND SATISFACTORY.

Signature of Customer's
Representative

Signature of Supplier's
Representative

EXPLANATORY NOTE

This standard gives detailed requirements of reciprocating pump.

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